AN ARTIFICIAL ROOT FOR INDUCING CAPILLARY MOVEMENT OF SOIL MOISTURE.

To the Editor of Science: The article in Science of October 27, 1904, page 566, under the above title calls for some comment on account of the fact that it does not, clearly and certainly follow, either from the evidence presented in the paper or from the conditions of the experiment, as stated, that the movement of soil moisture observed was in any way the result of capillary action. The subject of the paper is an important one, and perhaps a fuller statement of the conditions and observations will make the position taken by the authors tenable; but, from the evidence presented, it appears that the flow of water observed may have resulted solely from percolation, induced by the suction developed by the partial vacuum maintained in the filter chamber.

The authors state that 'When a tube of this kind is moistened, so that the pores are filled with water, and the tube is protected from evaporation, it can be exhausted to a pressure equal to the vapor pressure of water, and, if connected to a two-liter receiver, it will maintain that pressure for a day or more without sensible loss.' They also state that such 'A tube in good condition, when immersed in water and exhausted, will take up water at the rate of 50 grams per minute.' From these two statements it appears that the texture of the filter was sufficiently close so that, when wet, it was air-tight against a pressure of one atmosphere; but that when the capillary power or surface tension of the outer layer of the filter was rendered nil by immersion in water the flow into it was 50 grams per minute under the pressure which before gave no movement. It appears, therefore, that an essential condition of flow is the supersaturation of the outer wall of the filter, which, in effect, is equivalent to immersing it in water. It can hardly be assumed, however, from the evidence of the paper, that capillarity within the soil unaided is capable of supersaturating the wall of the filter where the soil is brought in contact with it and of maintaining it in this condition for days together. It is to be expected, however, that the placing of the outer wall of the filter in close contact with the soil did have the effect of practically augmenting the thickness of the wall, causing the filter to stand in the soil as a porous curbing to a well. When so placed, the capillary soil moisture may be expected to join with that of the wall of the filter, thus reducing, within the areas of good contact, the power of surface tension to withstand the suction from within; hence, along those lines, could be established a flow exactly as if the filter had been immersed in water, but purely through atmospheric pressure, capillarity taking little or no part in the movement. As the water escaped from the soil into the filter the reduced pressure would spread outward, and this would permit the soil air to sweep more water toward the filter and thus maintain the supersaturated condition about its wall until the soil moisture was so much reduced as to leave the soil open enough to permit air to come in contact with the filter; thus restoring, in effect, the condition of the filter described in the first quotation, with the wall only capillarily saturated and under which no flow took place. We do not feel, therefore, that the evidence which the authors present in the article referred to is sufficiently conclusive to warrant the views there expressed, or that they have succeeded in devising an artificial root which, in any essential way, can be said to represent or measure the natural movement of soil moisture in a soil toward an active root.

There is no doubt that if a method could be devised which would enable the rate of movement of soil moisture in the different soil types to be measured, under field conditions, an important advance could be made; but it is important to recognize that, even if it shall appear that the flow of water in the cases cited was due to capillarity, unless the method can be made capable of reducing the water lower than 17 per cent., in a soil whose maximum is 20 to 22 per cent., investigations made with it can have but a limited value. The force of this remark will be seen when it is pointed out that the lowest limit of moisture, in the soil experimented with, at which the flow ceased, was at least not lower than

the maximum amount the soil should contain, except for short intervals, in order to secure the best growth.

But even if the author's conclusions be not correct regarding the cause of the flow of water in the experiment, the line of investigation is important in that it has provided a means of securing water from field soil, perhaps, in a somewhat more concentrated condition than occurs in natural drainage and permits the sample to be taken where its history may be very definitely known; and it is to be hoped that they and others will apply the method in investigating the character of soil extracts thus obtained. We regard it extremely doubtful, however, that either the concentration or the composition of solutions so procured will be found to be the same as that which closely invests the soil grains or the root hairs at the same place and time. Certainly, if the movement is a capillary one, the observations recorded in the bulletin* on the 'Movement of Water-soluble Salts in Soils' indicate that very notable changes in the composition of the solution may take place as a result of the translocation. Our own observations also show that when only small quantities of some solutions are forced through such filters the concentration may be measurably changed. F. H. KING.

MADISON, WIS.,
November 2, 1904.

HYBRID WHEATS.

TO THE EDITOR OF SCIENCE: In my original paper on hybrid wheats (Bull. 115, O. E. S.) the second generation of crosses between long-head varieties (*Triticum vulgare*) and club wheats (*T. compactum*) were divided into long, short and intermediate heads, these three types occurring in the proportion 1 : 2 : 1. Subsequent examination of later generations of these wheats, all of which continue to obey Mendel's law quite strictly, leads me to believe that the short head of the club wheats is really a dominant character, and that the apparent intermediate character of the heads of the heterozygotes of the several generations of hybrids is due to the greater vigor of the heterozygote individuals. It was found in the third and later generations that the long and intermediate heads could be separated without error, as shown by the purity of the long heads next year. But there were many small errors in separating the intermediate and short heads. If the latter separation had been perfect, the short-head type should have reproduced true to type. But in a majority of the plats supposed to contain only short heads, a few long and about twice as many intermediate heads were found, indicating that in most cases one or more intermediates had been selected with the shorts the previous year. When the seed of each plant was kept separate, this difficulty disappeared, each plant behaving either as a pure short head type or as an ordinary heterozygote.

One of the most interesting results which subsequent study of these hybrids has brought to light is the apparent effect of hybridization on the variation of single characters. For instance, the length of head of the long-head parent of the hybrid is fairly uniform, but in the hybrid this character varies between wide limits. The same is true of the length of the short or club heads. In the parent club variety the heads are fairly uniform in length; but in the pure short-head progeny of the second and later generations some of the heads were less than one fourth the length of the ordinary club heads. This induced variability of a character which has recently passed through the stage of what we may call heterozygosis probably accounts for the errors made in separating the intermediate and short heads above referred to. It is also of capital importance to the practical breeder. Those who are so situated as to attempt it will find an interesting problem in the effect of selection in fixing these variable characters, should the power of yielding large quantities of seed be rendered highly variable by hybridization, and should we be able to fix unusual yielding power thus induced, we could establish races of great economic value.

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* 'Investigations in Soil Management,' by the author, Madison, Wis.